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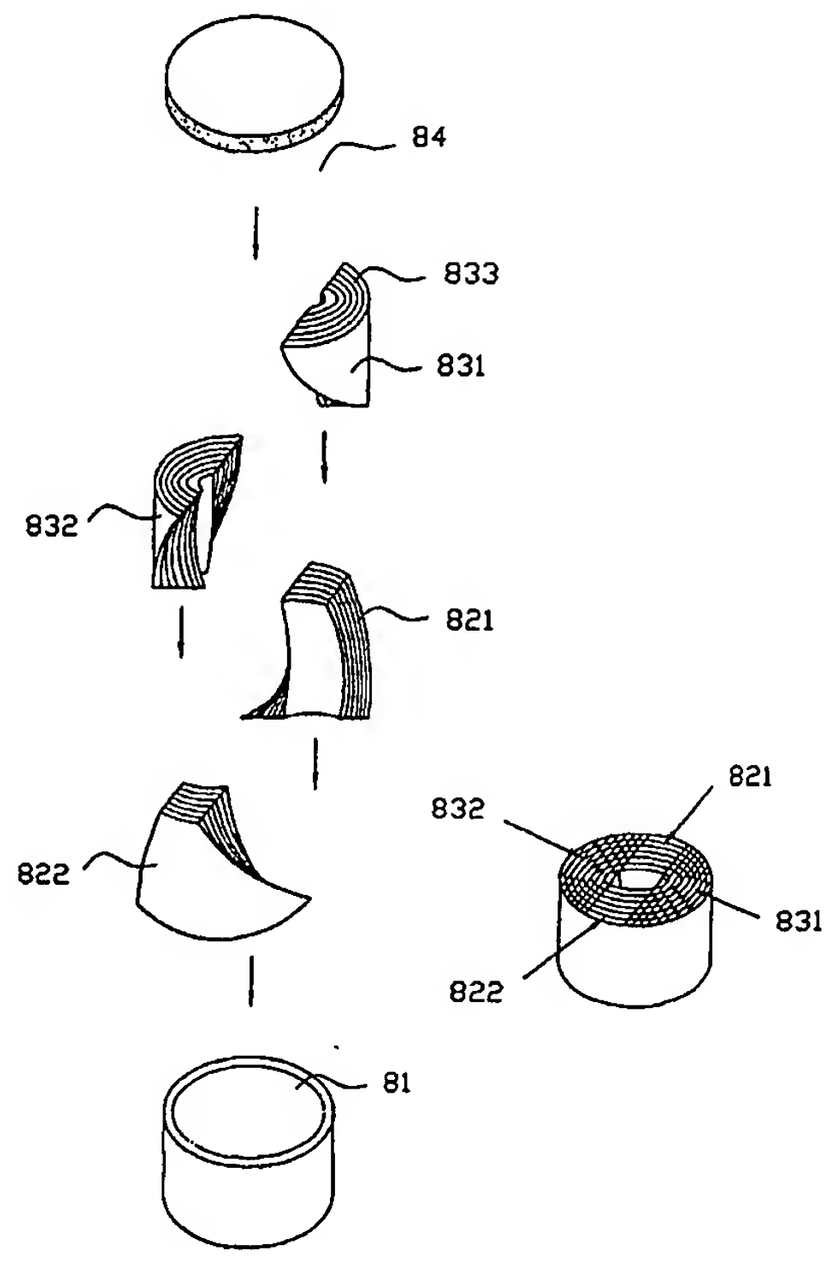

(57) Abstract: A multipolar integrated contact for power switchgear, its arc proof component, magnetic field generating component and conductive component are set in a container with top opened. Conductive component and magnetic field generating component are mutually combined and set at bottom of the container, arc proof component is set on top of the combination of conductive component and magnetic field generating component. Conductive component passes through center of the container, and from top to down, it equally divides the container; magnetic field generating component is isolated by conductive component and set at other part of the container. Contact surface of the invention has multiple pole axial magnetic field, the contact is suitable used for integrated contact for interrupting high volume current in arc extinguished chamber of vacuum interrupter. The invention belongs to electrical equipment field.

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A Multipotar Integrated Contact for Power Switchgear

Field of the invention

The present invention relates to a structure of integrated contact for power switchgear, especially a structure of integrated contact in arc extinguished chamber of vacuum interrupter. It belongs to electrical equipment field.

Background of the invention

Switchgear is an essential equipment in circuit which plays switching on and switching off function in the circuit. While switching off, switchgear has very high resistance in order to withstand certain voltage; While switching on, it must have very low resistance in order to pass rated current without overheat. During switchgear contacts interrupting, arc extinguishing is necessary to make contacts to be quickly separated. At present, there are different kinds of arc extinguishing medium: oil, sulphur hexafluride(SF_6), air, semiconductor and vacuum etc. Different arc extinguishing mediums correspond to different interrupter structure and with different properties. As vacuum interrupter has small gap, high withstand voltage, low arc voltage, high current interrupting capability, low electrode erosion and high electric life, so it is broadly used in power line under 35KV voltage. As shown in Fig. 1, the heart of a vacuum interrupter 7 is its vacuum arc extinguished chamber 6 within envelope 5. The properties of contacts 1 and 2 within vacuum arc extinguished chamber 6 determines properties of vacuum interrupter 7 directly. The rear of contacts 1 and 2 of vacuum interrupter 7 is connected to moving electrode 3 and stationary electrode 4, respectively, interruption of contacts 1 and 2 is mechanically operated by moving electrode 3. During interruption, contact area of contacts 1 and 2 is getting smaller until there is only one contact point between contacts 1 and 2. At the same time, contact resistance and area temperature are increased until the contact point is melted, vaporized and ionized. Metal vapor keeps discharge procedure to be continued in vacuum and produces vacuum arc, finally contacts are electrically interrupted. In order to raise interrupting capability of vacuum interrupter, it is necessary to provide vacuum arc with axial magnetic field, which maintains vacuum arc at a stable and dispersive state. In this way, current will be well distributed on contact surface, temperature on contact surface will be decreased and amount of vaporization of contact material is avoided, all of these maintaining arc voltage at a lower level and decreasing electrical erosion of contact. Therefore, contacts in arc extinguished chamber of vacuum interrupter must have abilities of burning arc, conducting electrically and producing magnetic field. Its technical parameters need to satisfy following requirements: excellent anti-welding characteristics, excellent voltage withstanding characteristics, high current-interrupting capability, excellent anti-electric erosion characteristics, low current chopping characteristics, low air content, high conductivity, small geometric size and high reliability etc. At present, the contact is consisted of arc proof component, conductive component and magnetic

field generating component. As shown in Fig. 2, the arc proof component 11 is set in the middle part and is consisted of copper-chromium (CuCr) material, which has large current interrupting capability and excellent anti-welding characteristics and produces metal vapor during interrupting time to maintain current. The conductive component 12 is a round contact body and generally consisted of copper material. The magnetic field generating component 13 is an inductance coil and set outside of the contact body; whether at an axial magnetic field or at a radius magnetic field, its magnetic field intensity is comparatively low. When assembly, it is necessary to solder in a vacuum and heating furnace with silver copper solder to combine the components together. As every component is complicated, once of soldering can only perform part of the soldering job; so during manufacturing, it is not only necessary to enter vacuum and heating furnace many times for soldering, but also exists the following problems which cause the contact electrical properties is not good enough: contact of the soldering surface is not 100%, quality of soldering surface and strength of soldering have not been guaranteed and burr on soldering surface is unavoidable etc. For reasons mentioned above, with present technology, production of vacuum interrupter not only has low ratio of final product, complicated procedure, these causing high cost, but has no ideal electrical properties as well. In addition, all components need various professional form of copper-chromium alloy materials and machining work, such as lathing and milling, of the alloy materials is complicated.

There is another product, developed by HOLEC Co., Netherlands, with present technology, its magnetic field generating component 13 discards the original coil form and substitutes it with a set of electrical iron sheets 13, which is piled on CuCr arc proof component 11 of contact body and is fasten with rivet 14. Electrical iron sheets 13 have different sizes of break 131, 132 and 133, magnetic field is produced by induced current in the electrical iron sheets, its concrete structures are shown in Fig. 3 and 4. The piled electrical iron sheets 13 on CuCr arc proof component 11 form a ladder-shaped, when it is seen from front view; this not only simplifies the original contacts structure, but also increases the magnetic field intensity greatly. Even with this structure, it has no choice to use the soldering method in order to combine the separated conductive component 12 and electrical iron sheet 13 together. As machining methods of the structure are unchanged basically, so its cost and quality still have quite a few problems. In addition, as electrical iron sheets 13 are piled in plane, according to the right-handed screw law, when magnetic induce reaches the break of sheets and goes up layer by layer to form an axial magnetic flux, so the magnetic resistance is comparatively high. Furthermore, as the sheets 13 are piled in a ladder-shaped form, the heat conductive body is an eccentric body; this asymmetrical heat conductive body makes instant heat diffusion effect badly; which not only influences contact interrupting capability, but also makes the whole structure deforms easily.

No matter which form it is used, a very important point for present contact structure is that, without any exception, every component of it is separately made. Therefore, the manufacturing procedures are various, the quality is unstable and the properties are not good enough. This is just like separated electronic element in early days, to implement an electrical function many separated elements need to be soldered together. This not only increases working procedures and size, but also decreases reliability and properties.

Except for the increasing cost by the complicated structure and manufacturing also procedure said above, the present technology to produce the contact wasted a great quantities of contact materials. Either as shown in Fig 2, the traditional structure, or as shown in Fig. 3 and 4, the improved structure, remaining leftover bits and pieces after manufacturing of components cannot be rationally used. So, the cost of the vacuum interrupter is increased naturally.

Another important point is that, with the present technology the axial magnetic field on the contact surface is not well distributed. At the same time, external stray magnetic fields influences interrupting capability of contacts obviously. Especially for the contact of high volume interrupter, its axial magnetic field is more concentrated on a local part and this leads to a worse interrupting capability under high volume current condition . This disadvantage is a big limitation for production of high volume vacuum interrupter. In practice, accompanying with electricity is widespread used, demand of high volume vacuum interrupter is increased rapidly; for example: electric generator asks control of I_B greater than 120 kA, distributing line using vacuum interrupter as interrupting device.

Sunmary of the invention

The main purpose of the present invention is to provide a multipolar integrated contact with integrated directly assembling structure, for power switchgear. With the invention, there is no need of soldering for combining and it changes the separated setting structure of all components in present technology.

The second purpose of the invention is to provide a multipolar integrated contact with tight structure and smaller geometric size, for power switchgear.

The third purpose of the invention is to provide a multipolar integrated contact that has high intensity of magnetic field, good heat conductivity, high interrupting capacity and longer electric live, for power switchgear.

The forth purpose of the invention is to provide a multipolar integrated contact that has high intensity of magnetic field, good heat conductivity, high interrupting capacity and longer electric live, for power switchgear.

The fifth purpose of the invention is to provide a multipolar integrated contact that has an axial magnetic field well distributed on the contact surface, which is adequate to high volume interrupter and has higher interrupting capacity, for power switchgear.

The sixth purpose of the invention is to provide a multipolar integrated contact that has no more remaining leftover bits and pieces of materials during manufacturing of components, so it saves materials greatly and decreases cost.

The seventh purpose of the invention is to provide a multipolar integrated contact for power switchgear, with components using general sections materials in market without any special sections materials.

Technical Solution

According to the present invention:

A multipolar integrated contact, comprising arc proof component, conductive component and magnetic field generating component, of power switchgear, the said arc proof component, the said conductive component and the said magnetic field generating component are set in a container with top opened; magnetic field generating component and conductive component are mutually combined and set at bottom of the container, and arc proof component is set on top of the combination of magnetic field generating component and conductive component; combination of magnetic field generating component and conductive component produces axial magnetic field.

The said conductive component passes through center of container and equally divides container form top to bottom; magnetic field generating component is isolated by conductive component and set in other part of container.

The said conductive component is set at middle of container and from top to bottom equally divides container into left and right parts.

The said conductive component is set at middle of container and from top to bottom equally divides container into more than two parts.

Front direction section of the said conductive component and magnetic field generating component is trapezium, and conductive component trapezium and magnetic field generating component trapezium are mutually coordinated.

The said magnetic field generating component can be a multi-layer cylinder structure with different diameter and is insulated between every layer, among them at least one is soft magnetic material layer.

The said multi-layer cylinder has more than one layer of soft magnetic material.

The said multi-layer cylinders are all soft magnetic material layers.

The said conductive component is a multi-layer cylinder combining structure with different diameter, at center of cylinder there is a cylinder body for inserting into central through hole of magnetic field generating component.

The said multi-layer cylinder of magnetic field generating component and multi-layer cylinder of conductive component has a same layer number.

The said magnetic field generating component is a layer shape body with one layer or more than one layer.

The said conductive component is a layer shape body with one layer or more than one layer.

Layer number of the said magnetic field generating component equals to layer number of the said conductive component.

The said container can be a cup-like body of rigid material, which melting point is higher than every inside component melting point.

The said container can be made of rustless steel with melting point higher than 1100 ^{0}C.

The said arc proof component is a mixture of copper powder and chromium powder.

Ratio of the said mixture of pure copper powder and pure chromium powder can be 10:90 to 90:10.

The said pure copper powder is 80 mesh to 400 mesh and pure chromium powder is 80 mesh to 400 mesh.

The said pure copper powder is 200 mesh to 400 mesh and pure chromium powder is 200 mesh to 400 mesh.

The said pure copper powder is 325 mesh and pure chromium powder is 325 mesh.

The said arc proof component is made of sheet or block of copper chromium alloy.

The said copper material can be substituted by silver material.

The said conductive component is made of material with electrical conduction, high magnetic resistance and heat conduction.

The said conductive component is made of copper.

Material state of the said conductive component can be powder, sheet, bar, tube or block.

Material state of the said magnetic field generating component can be powder, sheet, bar, tube or block.

The said magnetic field generating component, part or whole, is made of soft magnetic material.

The said soft magnetic material is electrical iron.

State of the said soft magnetic material can be powder, sheet, bar, tube or block.

Technical effects

According to analysis of technical scheme above, it is known that the invention has following advantages:

1. Technical thinking of integrated structure of the invention is all contact components are packed into a container. The meaning of this improvement is comparable with electronic circuit improved from separated element to integrated circuit. The whole-integrated structure changes thoroughly separated setting structure of present technology, it tightens geometric size, shrinks volume and increases current density.
2. It not only greatly expanses various derived combination type of magnetic field generating component and conductive component, but also makes powder materials, uncertain shape materials, can be used, as there is an external packing container. Therefore, the invention greatly expanses various general materials can be widespread used in contacts of vacuum interrupter.
3. Magnetic flux is efficiently generated, magnetic resistance is low, axial magnetic field intensity is very high and well distributed; magnetic flux comes in and goes out on contact surface many times and forms its own close loop; and it can better avoid influence of external stray magnetic fields on interrupting capability of contacts; so arc is well controlled and in a diffusion state. All of these increase interrupting capability.
4. As sections of magnetic field generating component and conductive component are mutually combined; it not only increases heat conductivity efficiency to raise

interrupting capability, but also solves damage of contact body caused by deformation due to asymmetry of heat contactor in present technology, and it also saves materials, as every cut component can be combined with another corresponding component, there is almost no leftover bits and pieces during manufacturing.

5. Materials of components need not be the alloy with certain ratio of CuCr manufactured specially for contact, and need not be special shape for components, but general copper, iron and rustless steel sections in market. This makes manufacturing easy and decreases cost.
6. Structure of every component is simple and easy to process and assemble. With entering furnace once and sealing once, the whole assemble is completed with high product ratio of up to standard.
7. It need not use soldering process, this not only saves solder, but also guarantees connection reliability of components.

Brief description of the zttached drawings

The accompanying drawings are incorporated in and constitute a part of this specification, illustrate particular embodiments of the invention, and together with the description, serve to explain, and not restrict, the principles of the invention.

Fig.1 is schematic diagram of arc extinguished chamber basic structure of present vacuum interrupter.

Fig2 is schematic diagram of contact structure of present arc extinguished chamber.

Fig.3 is schematic diagram of another contact structure of present vacuum interrupter.

Fig.4 is schematic diagram of plane structure of magnetic field generating component shown in Fig. 3.

Fig.5 is perspective schematic diagram of contact structure of the first preferred embodiment of the invention.

Fig.6 is magnetic loop diagram of axial magnetic field shown in Fig. 5.

Fig.7 is schematic central section diagram of cylinder setting combining structure of magnetic field generating component and conductive component shown in Fig. 5.

Fig.8 is axial magnetic field distribution diagram on contact surfaces of embodiments shown in Fig. 5, 6 and 7.

Fig.9 is schematic diagram of contact structure of the second embodiment of the invention.

Fig. 10 is schematic central section diagram of layer setting combining structure of magnetic field generating component and conductive component of embodiment shown in Fig. 9.

Fig.11 is axial magnetic field distribution diagram on contact surfaces of embodiments shown in Fig. 9 and 10.

Preferred embodiments

The main thinking of the invention is to set contact components, which are separately set in original, into a container, which acts an external package of the contact so that the contact has a integrated whole structure. Specifically, magnetic field generating component and conductive component are mutually combined and set at bottom of the container, arc proof component is set on top of the combining of magnetic field generating component and conductive component. Magnetic field generating component has magnetic path open break. The combining of magnetic field generating component and conductive component produces axial magnetic field. Container can be cup-like body, and its materials is rigid, melt point of that is higher than melting point of any component in the container, for example, container material can be melting point higher than 1100^0 C rustless steel. Conductive component material can be conductive, electric and heat, and high magnetic resistance. If pure copper or red copper material is used, its melting point is 1083^0 C. In order to have a melting state of conductive component in furnace, temperature of furnace must be higher than 1083^0 C. Therefore, melting point of container must be higher than 1100^0 C. Part or all materials of magnetic field generating component are soft magnetic materials, for example electric iron.

As there is a container outside contact, state of arc proof component, magnetic field generating component and conductive component can be powder, sheet, bar, tube or block, if they can produce axial magnetic field with magnetic flux coming in and going out on contact surface.

The arc proof component 84 is made of block or plate of alloy material of pure copper and pure chromium. For further lowing cost of materials, alloy material, produced specially, of pure copper and pure chromium is no longer used for arc proof component and is substituted by mixture of general copper powder and chromium powder. According to different requirements, the ratio of copper powder and chromium powder can be varied from 10:90 to 90:10. In addition, the copper powder is preferred 325 mesh, the chromium powder is preferred 325 mesh, and the copper powder can be substituted by silver powder.

Embodiment 1, as shown in Fig. 5 - 8, it is a schematic diagram of structure of another preferred embodiment of the invention. Specifically, arc proof component 84, conductive component 821, 822, and magnetic field generating component 831, 832 of contact 8 are set in a cup-like body container 81 with top opened. Conductive component 821, 822, and magnetic field generating component 831, 832 are combined and set at bottom of cup-like body container 81, and arc proof component 84 is set on top of the combination of conductive component 82 and magnetic field generating component 831, 832. Shape of the combination of magnetic field generating component 831, 832 and conductive component 821, 822 is coordinated with cylinder shape of cup-like body container 81. As shown in Fig.6 and Fig.8, according to right-handed screw law, when conductive component 821, 822 has current, magnetic field generating component 831, 832 produces magnetic field, axial magnetic flux of that comes in and goes out on contact surface with multiple times, i.e. magnetic flux forms close loop, which comes in and goes out on contact placed oppositely in multiple times. Therefore, magnetic field is well distributed on contact surface, and the contact is suitable to interrupt high volume current.

In this embodiment, front sections of conductive component 821, 822 and magnetic field generating component 831, 832 are trapeziums. Trapeziums of conductive component 821, 822 and trapeziums of magnetic field generating component 831, 832 are mutually coordinated, so the combination of them is corresponding to cylinder shape body of cup-like container.

Conductive component 821, 822 setting passes through center of cup-like body 81, and equally divides cup-like body 81 into two halves, left and right; magnetic filed generating component 831, 832 is isolated by conductive component 821, 822 and set at remain part of cup-like body 81. In this embodiment, conductive component 821, 822 is combining structure of multiple cylinders with different diameter, and a cylinder body is set at center of cylinders for inserting into central through hole of magnetic field generating component. Magnetic field generating component 831, 832 can be a more than one layer combining cylinder body structure 833 with different diameter and is isolated between layers. Multiple cylinder body 833 can have one layer soft magnetic material, or more than one layer of soft magnetic material or all layer of soft magnetic material, to produce different required intensity of magnetic field. Of course, layer number of multi-layer cylinder of magnetic field generating component 831, 832 equals to layer number of multi-layer cylinder of conductive component 821, 822. In addition, conductive component 821, 822 can also be an entire entity. Furthermore, at contact top position, width of conductive component 821, 831 can be greater than real electromagnetic physical gap between two contacts placed oppositely in interrupter, to guarantee axial magnetic field intensity between two contacts.

Embodiment 2, reference to Fig. 9 - 11, conductive component 82 is set at middle of cup-like body container 81; and from top to bottom, cup-like body container 81 is equally divided into three parts by conductive component 82. Magnetic field generating component 83 and conductive component 82 are combined with trapezium setting; wherein conductive component 82 and magnetic field generating component 83 are piled layer by layer with one layer or more than one layer; each layer of conductive component 82 and each layer of magnetic field generating component 83 are mutually combined. From bottom to top, each layer area of conductive component 82 is gradually decreased and each layer area of corresponding magnetic field generating component 83 is gradually increased. After mutually combining of conductive component 82 and magnetic field generating component 83, the combination shape is coordinated with inner wall shape of cup-like body container 81, and arc proof component 84 is set at top of the combination. According to right-handed screw law, when current passes conductive component 82, magnetic field generating component 83 produces magnetic field, axial magnetic flux of that three times coming in and three times going out on contact surface, i.e. magnetic flux forms magnetic field close loop with three times coming in and going out the contact placed oppositely . Therefore, on contact surface, magnetic field is well distributed and powerful, that is suitable to interrupt high volume current.

Every component of the invention can be various materials with various states. For example, material of conductive component 82 can be conductive, electric and heat, and high magnetic resistance, such as copper, its state can be powder, sheet, bar, tube or block; material of magnetic field generating component 83 can be partly or totally soft magnetic material, such as electrical iron. Part of magnetic field generating component 83 state can be powder, sheet, bar, tube or block. State of soft magnetic material can be powder, sheet, bar, tube or block.

According to structure design of the invention, production process of interrupter contact can be simplified as once entering furnace and once sealing to complete whole assembly. In addition, there is no need of soldering process, it is not only save solder, but also guarantee reliability of component connection and high up standard of product.

It will be apparent to those skilled in the art that various modifications can be made to the present cell selection method without departing from the scope and spirit of the present invention. It is intended that the present invention covers modifications and variations of the systems and methods provided they fall within the scope of the claims and their equivalents. Further, it is intended that the present invention cover present and new applications of the system and methods of the present invention.

Claims

1. A multipolar integrated contact, comprising arc proof component, conductive component and magnetic field generating component, of power switchgear, the said arc proof component, the said conductive component and the said magnetic field generating component are set in a open container; magnetic field generating component and conductive component are mutually combined and set inside the container, and arc proof component is set on top of the combination of magnetic field generating component and conductive component; combination of magnetic field generating component and conductive component produces axial magnetic field.
2. According to claim 1, wherein the said multipolar integrated contact for power switchgear, the said conductive component passes through center of container and equally divides container form top to bottom; magnetic field generating component is isolated by conductive component and set in other part of container.
3. According to claim 2, wherein the said multipolar integrated contact for power switchgear, the said conductive component is set at middle of container and from top to bottom equally divides container into left and right parts.
4. According to claim 2, wherein the said multipolar integrated contact for power switchgear, the said conductive component is set at middle of container and from top to bottom equally divides container into more than two parts.
5. According to claims 3 or 4, wherein the said multipolar integrated contact for power switchgear, front direction section of the said conductive component and magnetic field generating component is trapezium, and conductive component trapezium and magnetic field generating component trapezium are mutually coordinated.
6. According to claim 1,2,3 or 4, wherein the said multipolar integrated contact for power switchgear, the said magnetic field generating component can be a multi-layer cylinder structure with different diameter and is insulated between every layer, among them at least one is soft magnetic material layer.
7. According to claim 6, wherein the said multipolar integrated contact for power switchgear, the said multi-layer cylinder has more than one layer of soft magnetic material.
8. According to claim 6, wherein the said multipolar integrated contact for power switchgear, the said multi-layer cylinders are all soft magnetic material layers.
9. According to claim 1,2,3 or 4, wherein the said multipolar integrated contact for power switchgear, the said conductive component is a multi-layer cylinder combining structure with different diameter, at center of cylinder there is a cylinder body for inserting into central through hole of magnetic field generating component.
10. According to claims 6 or 9, wherein the said multipolar integrated contact for power switchgear, the said multi-layer cylinder of magnetic field generating

component and multi-layer cylinder of conductive component have same layer number.

11. According to claim 1, 2,3 or 4, wherein the said multipolar integrated contact for power switchgear, the said magnetic field generating component is a layer shape body with one layer or more than one layer.

12. According to claim 1,2,3, or 4, wherein the said multipolar integrated contact for power switchgear, the said conductive component is a layer shape body with one layer or more than one layer.

13. According to claims 11 or 12, wherein the said multipolar integrated contact for power switchgear, layer number of the said magnetic field generating component equals to layer number of the said conductive component.

14. According to claim 1, wherein the said multipolar integrated contact for power switchgear, the said container can be a cup-like body of rigid material, which melting point is higher than every inside component melting point.

15. According to claim 14, wherein the said multipolar integrated contact for power switchgear, the said container can be made of rustless steel with melting point higher than 1100^0 C.

16. According to claim 1, the said integrated contact for power switchgear, it is characterized that: the said arc proof component is a mixture of copper powder and chromium powder.

17. According to claim 16, wherein the said multipolar integrated contact for power switchgear, ratio of the said mixture of pure copper powder and pure chromium powder can be 10:90 to 90:10.

18. According to claims 16 or 17, wherein the said multipolar integrated contact for power switchgear, the said pure copper powder is 80 mesh to 400 mesh and pure chromium powder is 80 mesh to 400 mesh.

19. According to claim 18, wherein the said multipolar integrated contact for power switchgear, the said pure copper powder is 200 mesh to 400 mesh and pure chromium powder is 200 mesh to 400 mesh.

20. According to claim 19, wherein the said multipolar integrated contact for power switchgear, the said pure copper powder is 325 mesh and pure chromium powder is 325 mesh.

21. According to claim 1, wherein the said multipolar integrated contact for power switchgear, the said arc proof component is made of sheet or block of copper chromium alloy.

22. According to claim 16, wherein the said multipolar integrated contact for power switchgear, the said copper material can be substituted by silver material.

23. According to claim 1, wherein the said multipolar integrated contact for power switchgear, the said conductive component is made of material with electrical conduction, high magnetic resistance and heat conduction.

24. According to claim 23, wherein the said multipolar integrated contact for power switchgear, the said conductive component is made of copper.

25. According to claim 1, wherein the said multipolar integrated contact for power switchgear, material state of the said conductive component can be powder, sheet, bar, tube or block.
26. According to claim 1, wherein the said multipolar integrated contact for power switchgear, material state of the said magnetic field generating component can be powder, sheet, bar, tube or block.
27. According to claim 1, wherein the said multipolar integrated contact for power switchgear, the said magnetic field generating component, part or whole, is made of soft magnetic material.
28. According to claim 27, wherein the said multipolar integrated contact for power switchgear, the said soft magnetic material is electrical iron.
29. According to claim 29, wherein the said multipolar integrated contact for power switchgear, state of the said soft magnetic material can be powder, sheet, bar, tube or block.

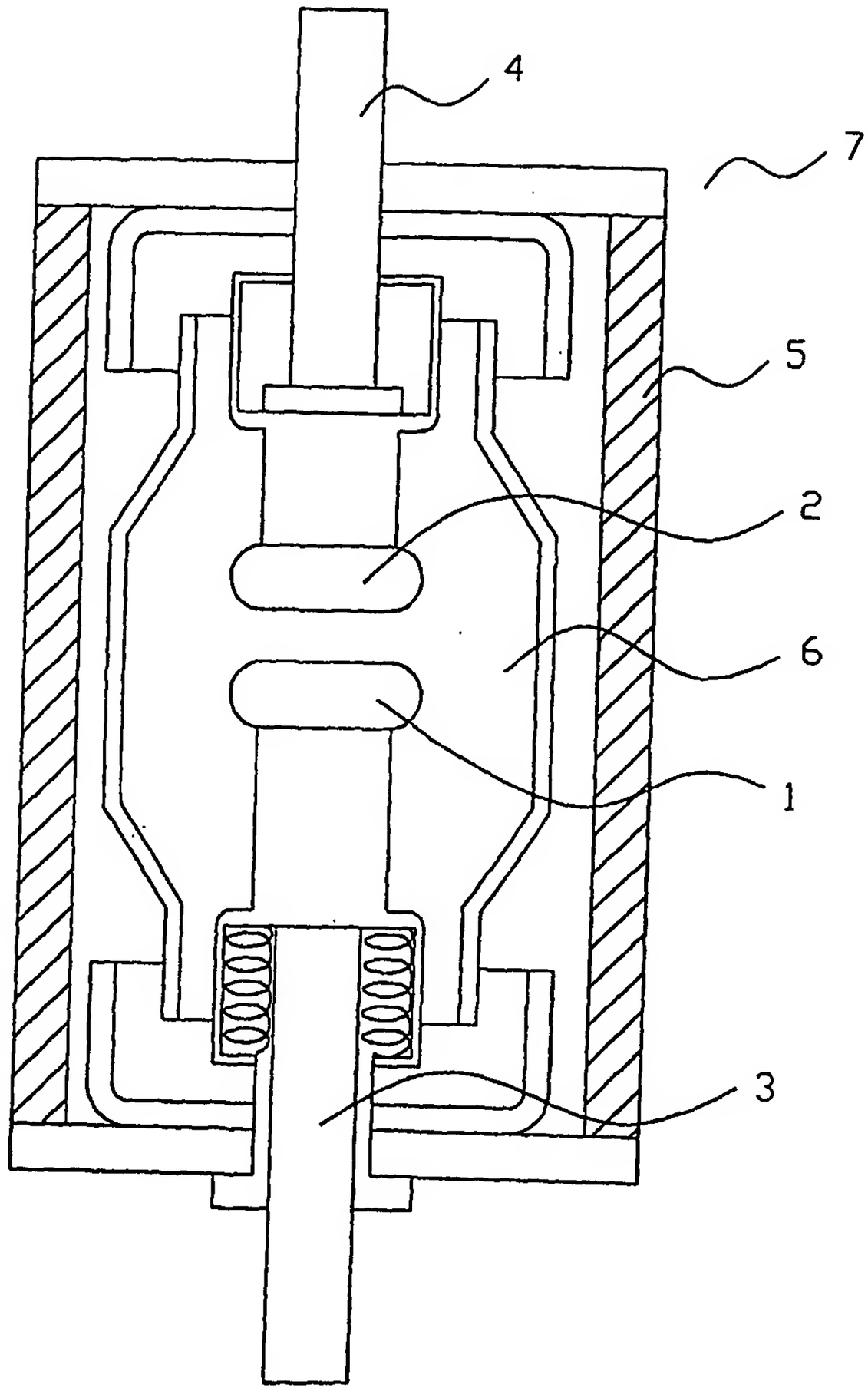

Figure 1

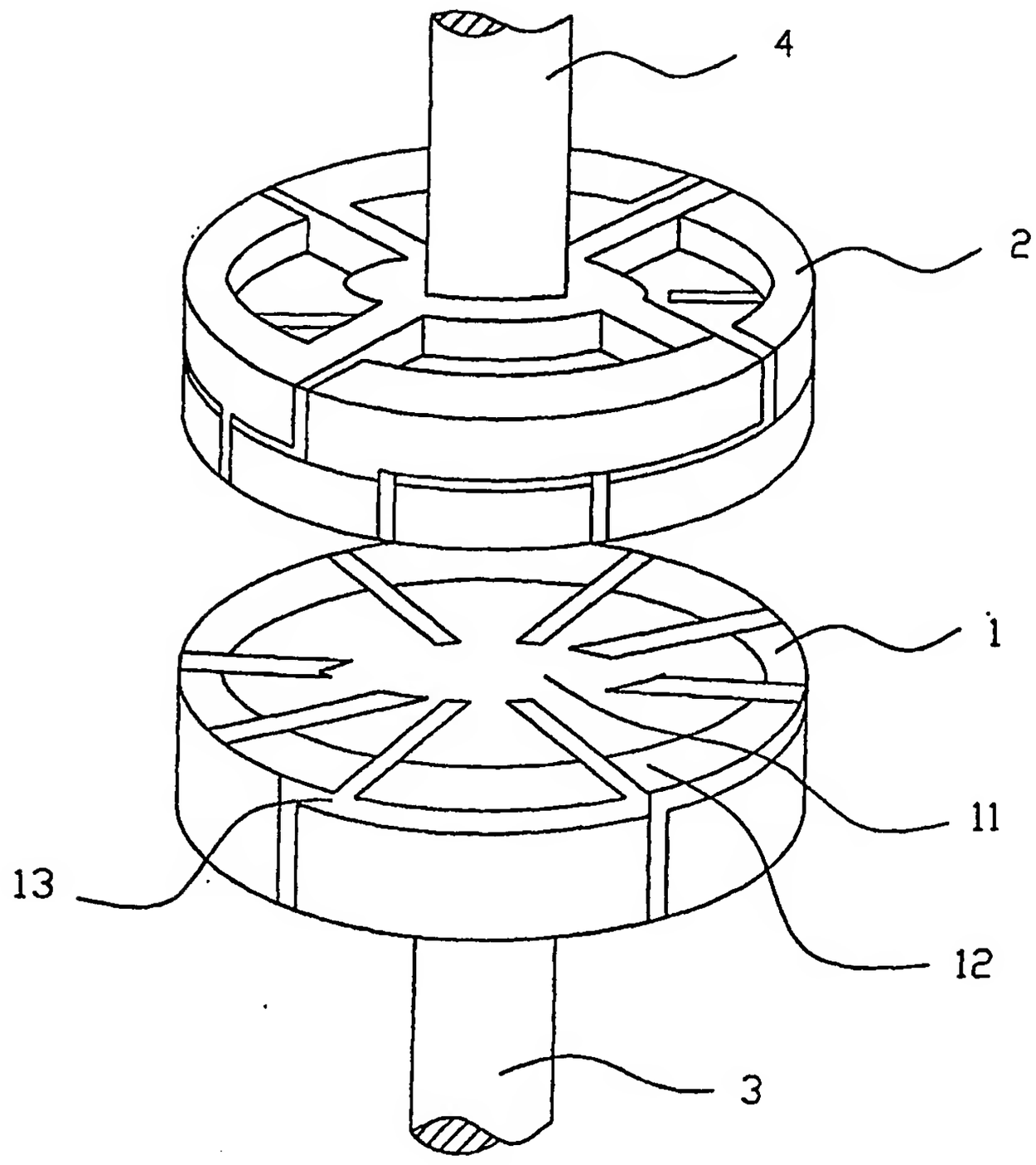

Figure 2

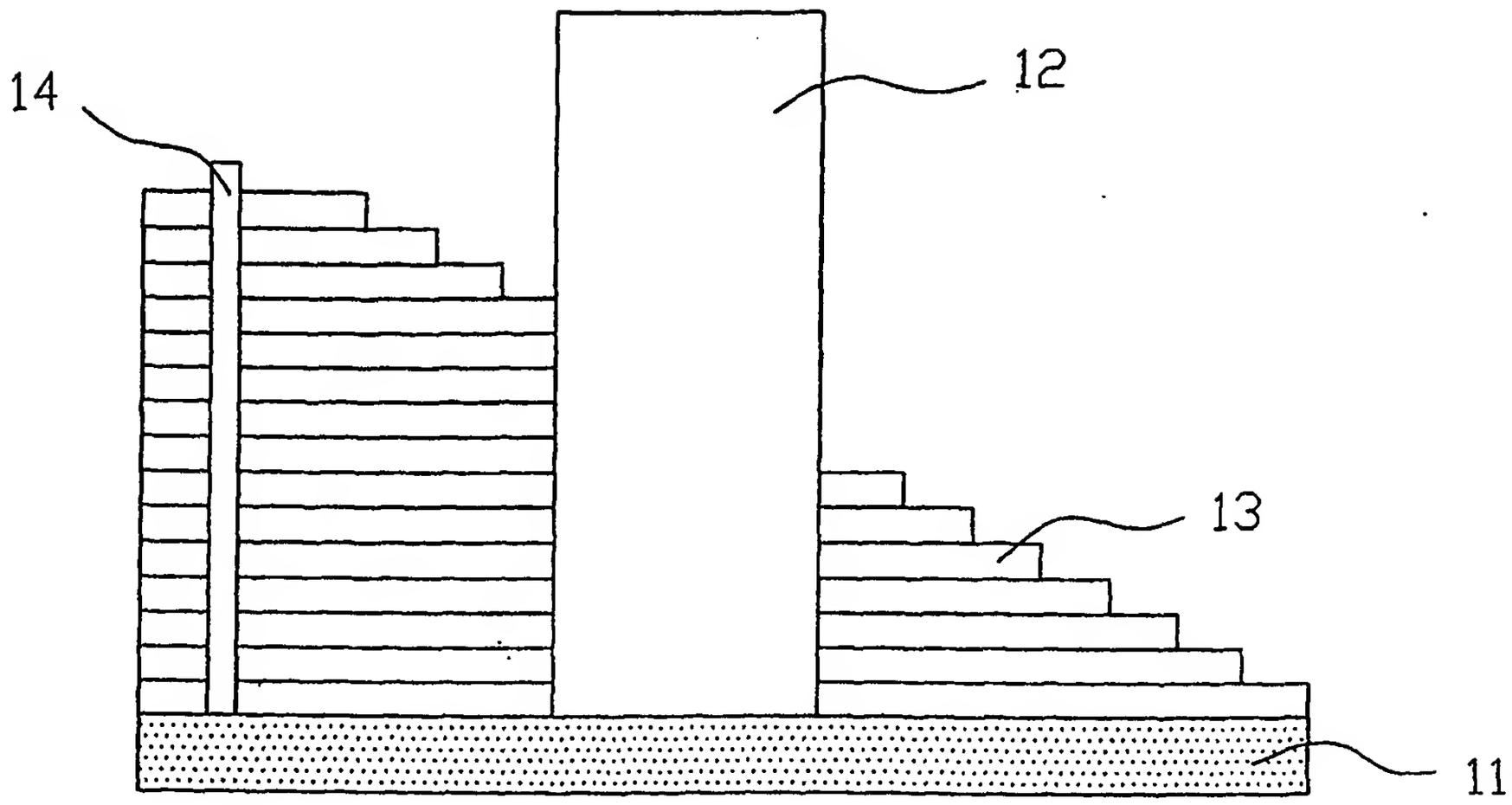

Figure 3

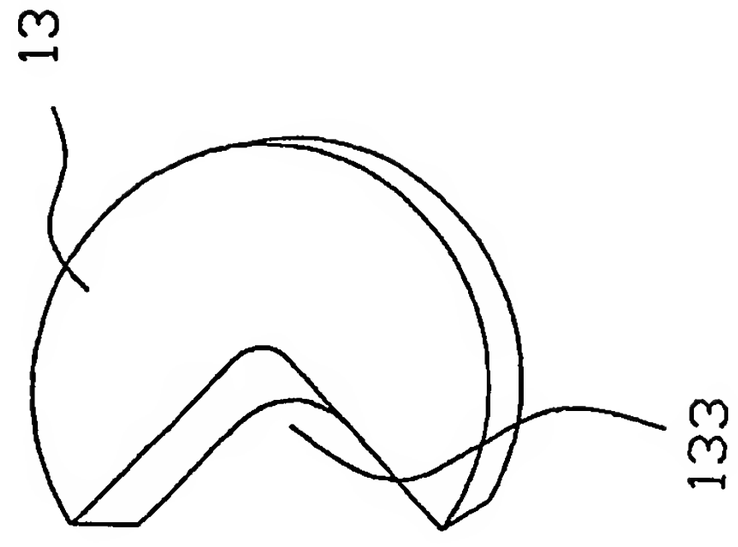

Figure 4

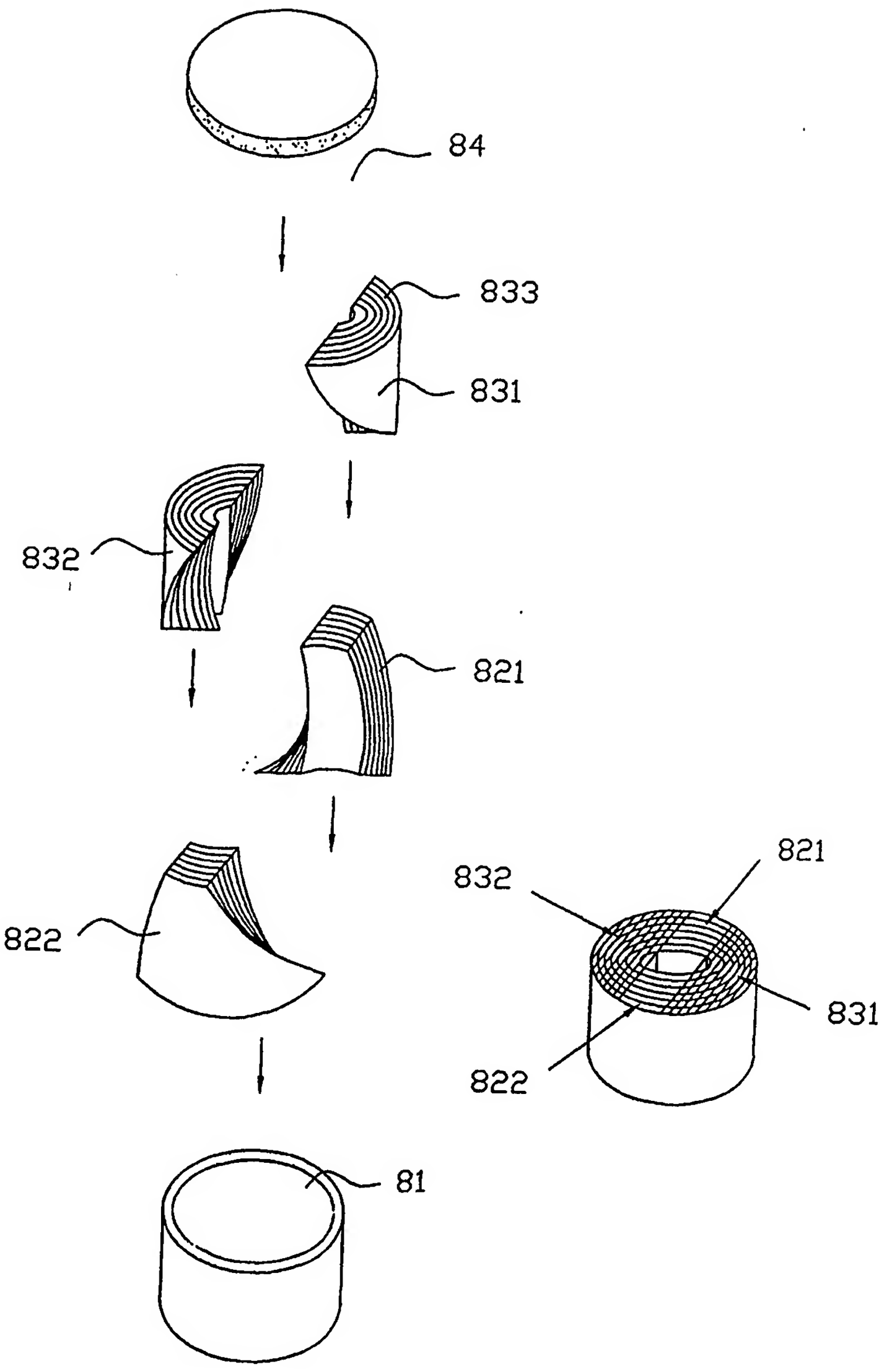

Figure 5

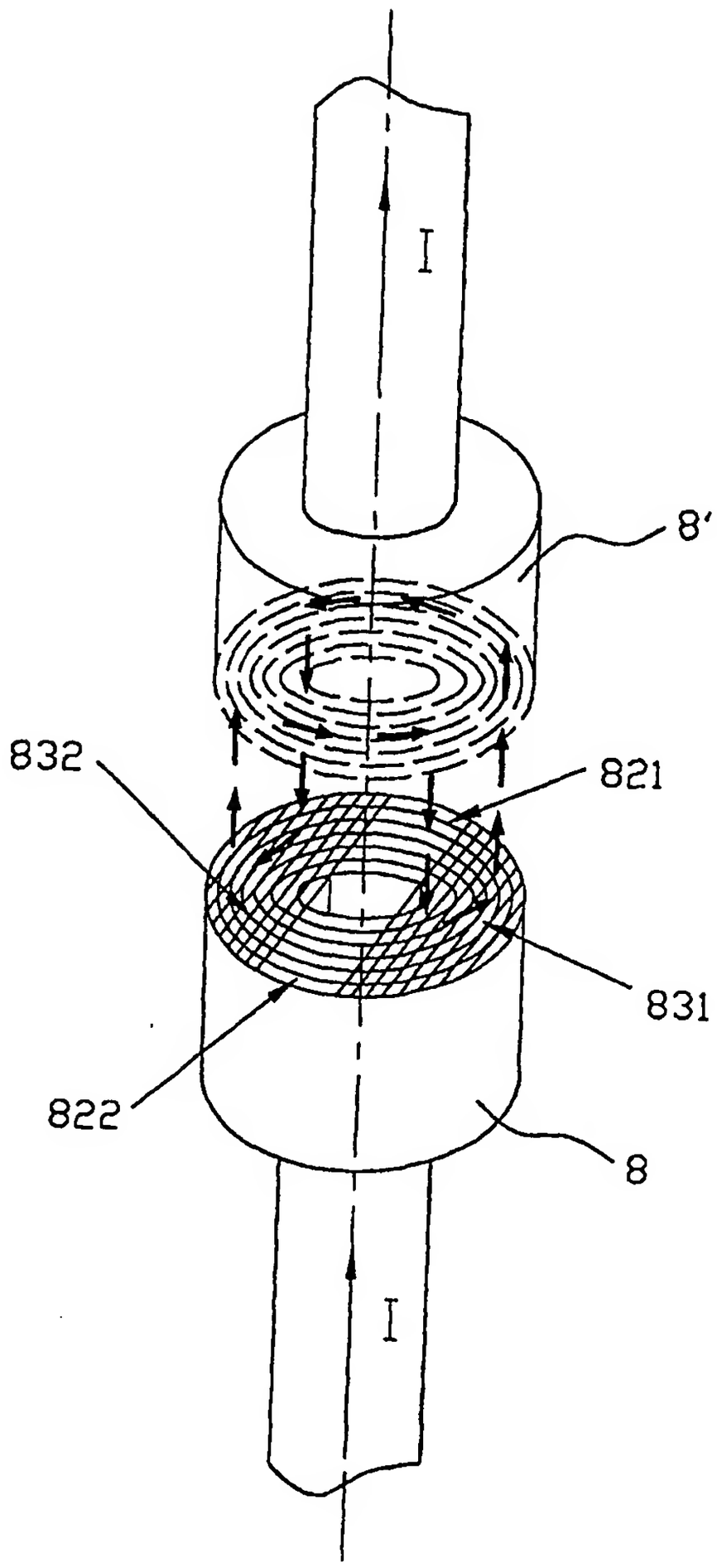

Figure 6

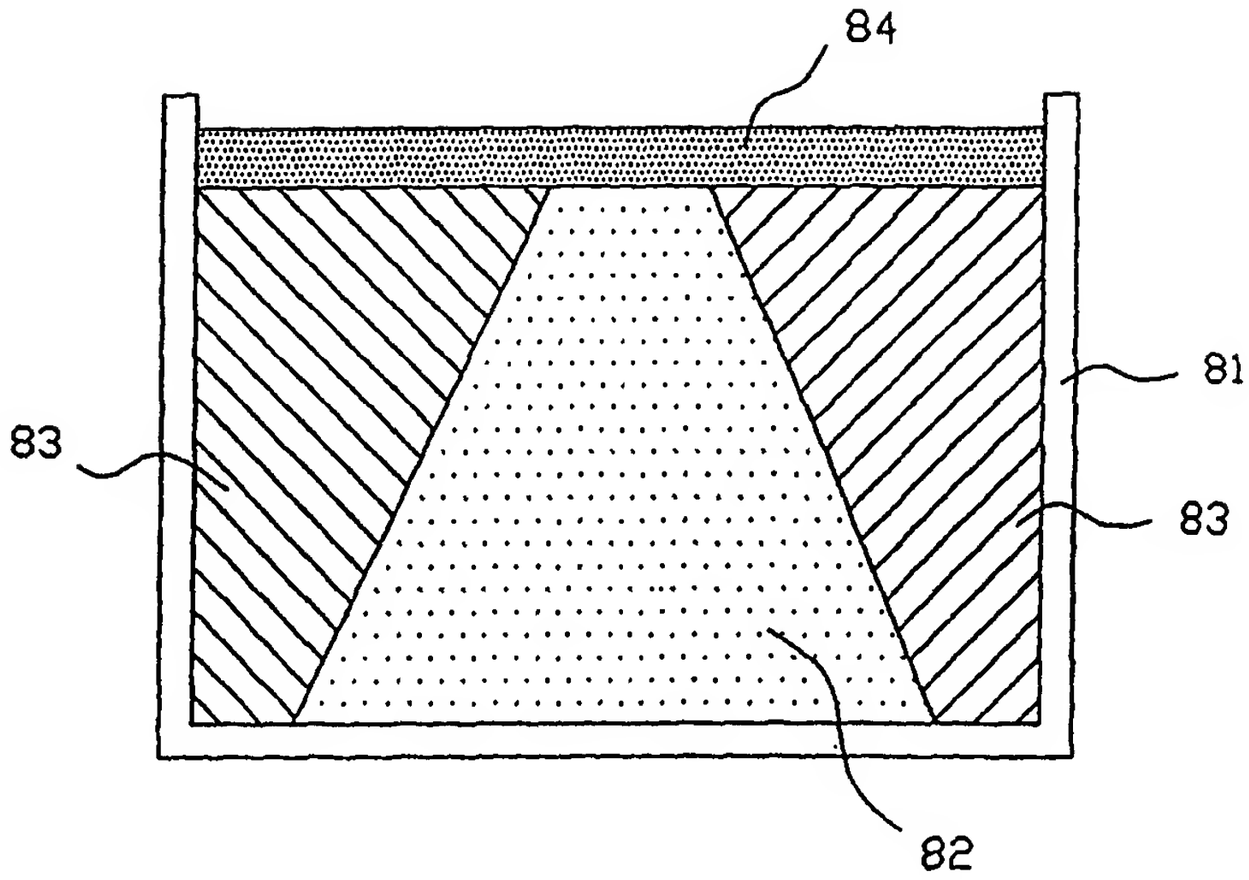

Figure 7

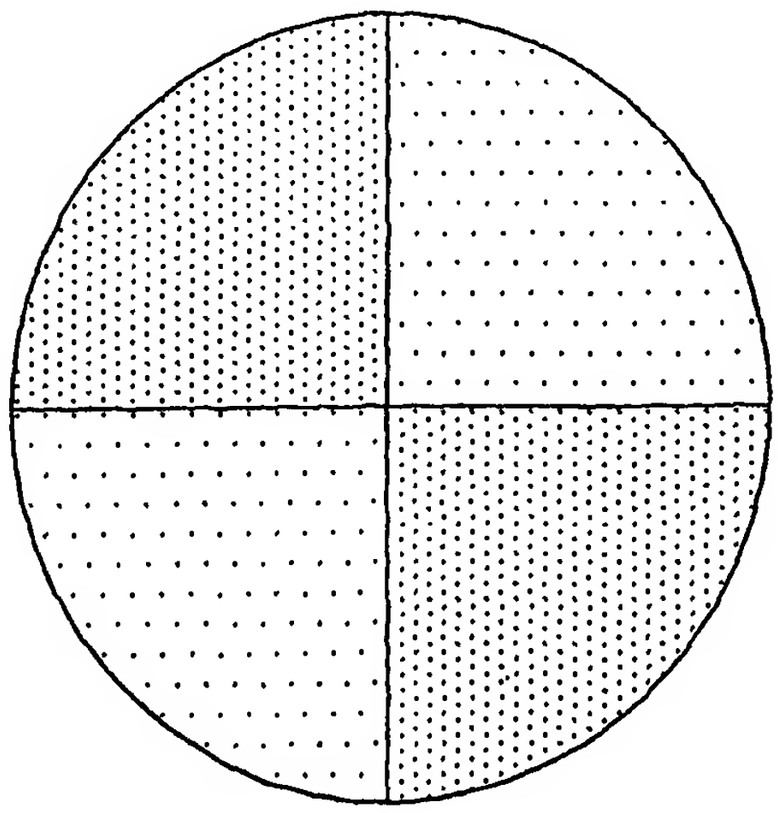

Figure 8

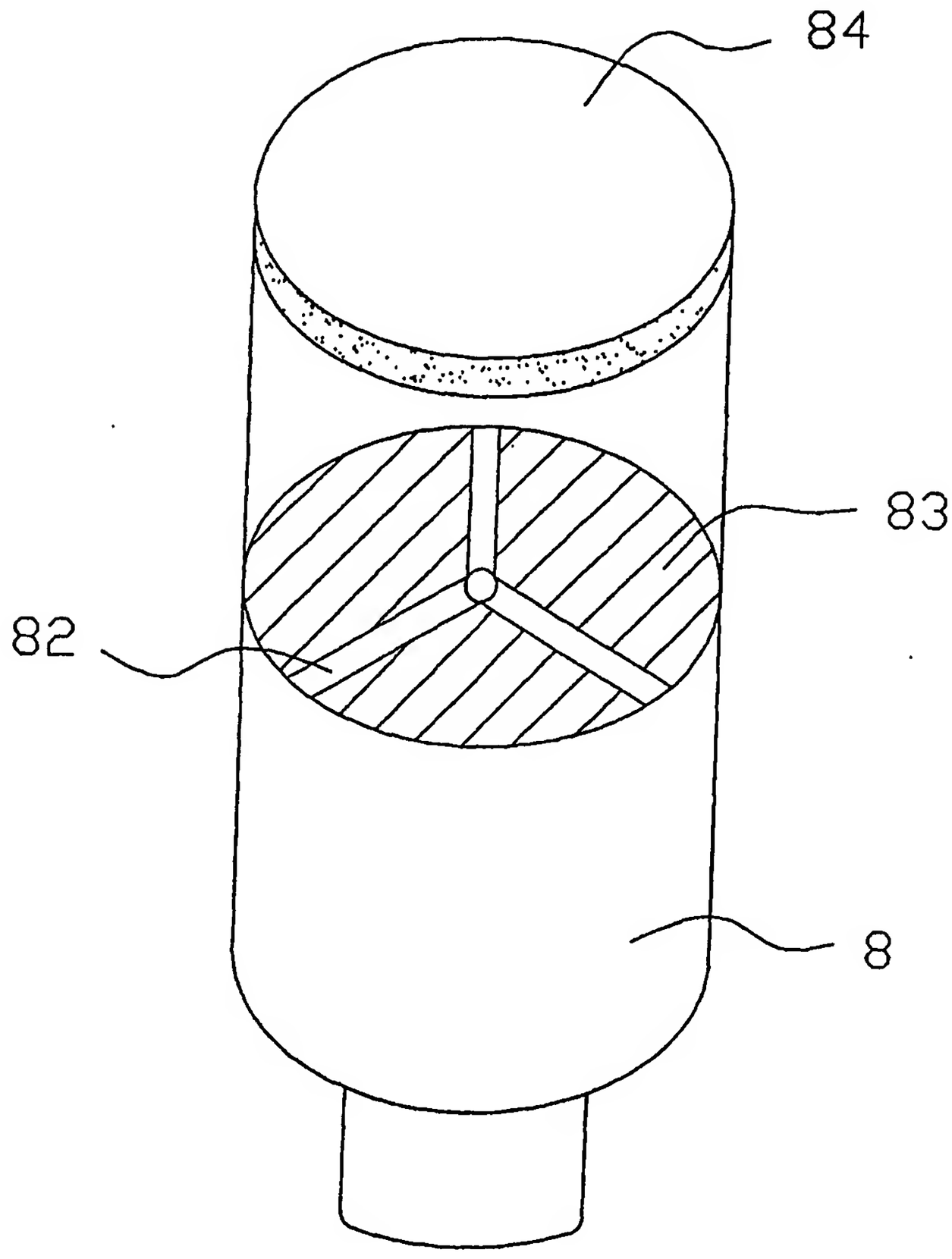

Figure 9

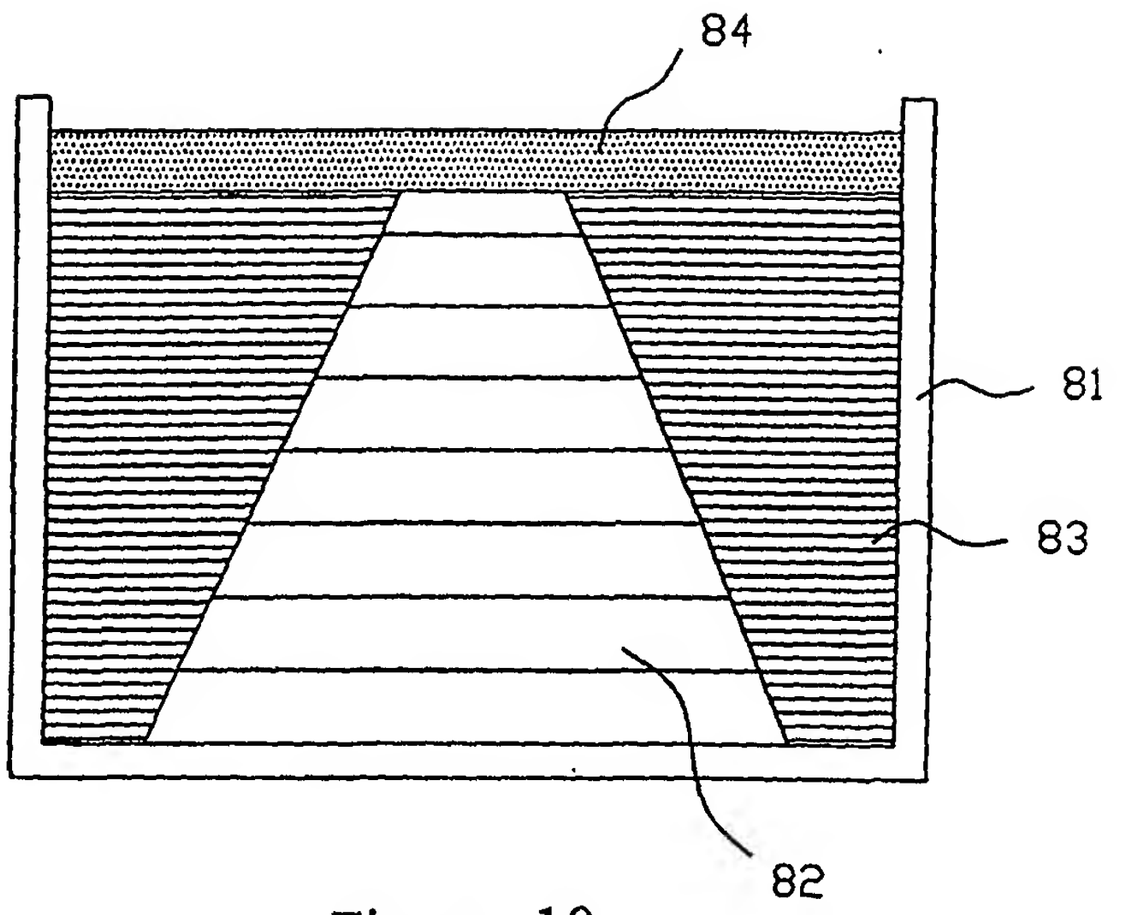

Figure 10

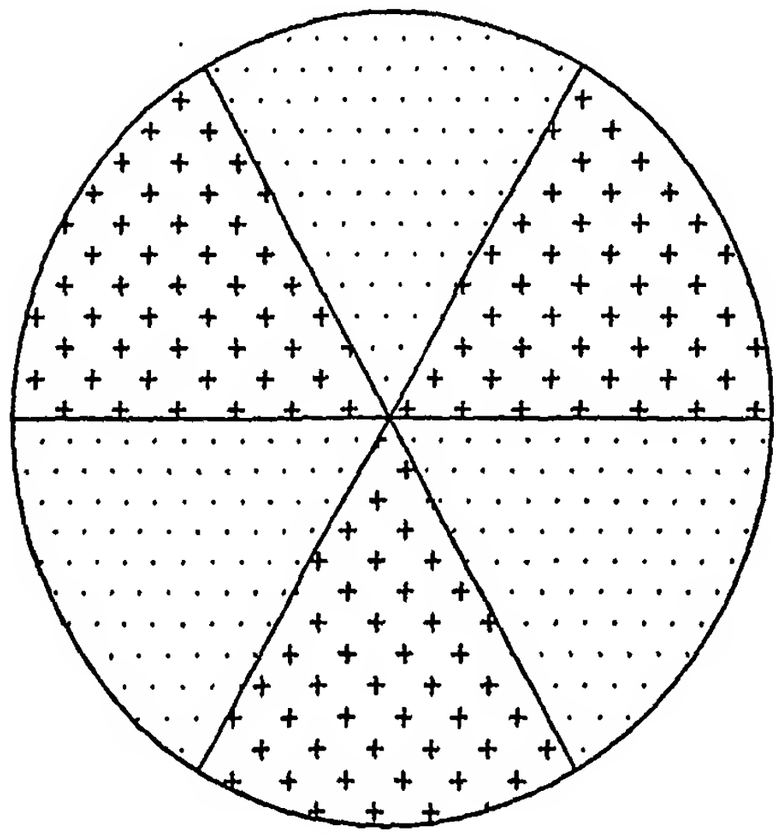

Figure 11